

Summary of Meeting #9, of RTCA SC-186, Working Group 5
For the Development of a MOPS for UAT
<http://adsb.tc.faa.gov/ADS-B/186-subf.htm>

The meeting was held on 10, 11 & 14 December 2001, in the MacIntosh Conference Room at the RTCA Headquarters in Washington DC. The meeting was called to order at 9 a.m. on 10 December 2001 by Co-Chairman George Ligler. George provided introductory remarks, welcomed all attendees and asked that each one introduce themselves and their organization. The attendees included:

Larry Bachman – JHU – APL	Stan Jones – Mitre CAASD	Ei Mon Phyu – Titan – FAATC – ACT-350
John Barrows – Supporting the FAA	Todd Kilbourne – Trios Associates	Bernald Smith – Soaring Society of America
Mike Biggs – FAA – ASR-200	Greg Kuehl – UPS Airlines	Tom Teetor – DCA
Mike Castle – JHU – APL	George Ligler – PMEI	Dave Thomas – Titan – FAATC – ACT-350
Bill Flathers – Consultant to AOPA	Robert Manning – HQ USAF/XOR GANS	Cmdr Richard Weathers – US Navy JCS J6T
Gary Furr – Titan Corp - FAATC – ACT-350	Chris Moody – Mitre CAASD	Warren Wilson – Mitre Corp.
Carl Gleason – Advancia – FAA/NISC	Tom Mosher – UPS Aviation Technologies	Tom Wright – Joint Spectrum Center
James Higbie – JHU – APL	Al Muaddi – JHU – APL	
Richard Jennings FAA (AIR-130)	Tom Pagano – FAA Tech Ctr – ACT-350	

- The following known regrets to attendance to this meeting were received prior to the meeting:
 - Ed Valovage, Sensis Corporation
 - Nikos Fistas, Eurocontrol Headquarters
- The Working Group was asked to review and approve the Minutes to Meeting #8. Hearing no comments or objections, the Minutes to Meeting #8 were approved as published.
- The Working Group discussed future meeting dates and locations. The following table indicates the currently agreed upon meeting dates and places for meetings of RTCA SC-186 Working Group #5.

Dates/Time	Meeting Place
9am Monday, 28 Jan to noon, Friday, 1 Feb	Confirmed at the Atlanta Airport Marriott. 20 rooms held under “RTCA UAT MOPS” at \$93. Govt rate. Must make reservation prior to 6 January 2002 to guarantee the rate.
9am Monday, 4 March to 4pm, Thursday, 7 March	Confirmed at Eurocontrol Headquarters in Brussels, Neptune conference room as hosted by Nikos Fistas.
9am Monday, 8 April to noon Friday, 12 April	To be held in conjunction with the SC-186 Plenary at the new RTCA facilities at 1828 L Street NW, Suite 805 (202-833-9339) Plenary plans to meet two days, with specific days TBD Travel info and lodging details are available on the ADS-B/UAT web site
9am Monday, 29 April to 4pm Friday, 3 May	Hosted at the William J Hughes FAA Technical Center in Atlantic City NJ Travel info and lodging details are available on the ADS-B/UAT web site
9am Monday, 17 June to 4pm Friday, 21 June	To be held in conjunction with the SC-186 Plenary at the new RTCA facilities at: 1828 L Street NW, Suite 805 (202-833-9339) WG-5 to meet Mon, Tues & Wed with Plenary on Thurs & Fri Travel info and lodging details are available on the ADS-B/UAT web site

- Following Agenda Item 4, George Ligler called on Mike Biggs to recap the results of the AMCP Working Group “F” meeting that Mike attended recently in Bangkok Thailand. Mike indicated that he thought that the meeting went well. Mike reports that there are some concerns in the communications community regarding placing airborne transmitters in at least one of the frequency

bands proposed by VDL-M4. What this could mean is that VDL-M4 might not come up for a frequency allocation, at least in the 108-118 MHz Band, until the WARC to be held in 2006. Mike also reports that several AMCP States report that they have already started checking the frequency assignments related to a possible UAT frequency. There will be another WG-F meeting prior to the next WG-C meeting, which means that if we can solidify the 978 MHz frequency issue soon, there can be a recommendation from WG-F to WG-C on the frequency and a recommendation to start UAT SARPS.

George Ligler then reported that he and Brent Phillips met with the WG-C Secretary, Alessandro Capretti on 29 November and discussed the briefing that George and Brent gave to the ICAO Air Navigation Commission on 30 November. Much of the briefing was a review of the TLAT report and the status of changes since it was published.

5. The Working Group then began the review of Selected Open Action Items, and Larry Bachman requested that we review a presentation that was assigned Working Paper number UAT-WP-9-10, which had been prepared by Albert Muaddi in response to Action Item 8-10. WP-9-10 reviews the assignments of DMEs in the Asia-Pacific region. The study found no assignments on 978 MHz.
6. As part of the review of Agenda Item 5a, Larry Bachman presented his “Preliminary UAT Model Results,” which were assigned a Working Paper Number of UAT-WP-9-11. Larry described the changes and additions to the models since the results were last reviewed in the Norfolk meeting. During review of the results, it was agreed that more simulations are required to show results at short range. It was concluded that from the results presented, in the LA2020 Scenario, all receiver types meet all of the current air-to-air MASPS update requirements for both flight levels reviewed at 15,000 and 40,000 feet. Additionally, with future Core Europe Scenario self-interference densities, for current populations of DME and TACAN (including on-tune DME/TACANs), MASPS requirements are generally not met, and overall performance is much worse than in previous simulations. In the Core Europe 2015 Scenario, with 978 MHz DME/TACANs presumed moved, with full use of all DME/TACAN allocations at 979 MHz, and a JTIDS “Baseline B” interference component, all receiver types were reported to meet all current air-to-air MASPS update requirements for stated ranges for flight levels of 15,000 and 40,000 feet. Performance in this scenario was seen to extend to approximately 120 nmi.
7. The Working Group then agreed to review the “Simulation Roadmap” as proposed by Chris Moody in a revised version of Working Paper UAT-WP-9-03. The revised WP-9-03A will be posted on the ADS-B/UAT web site after the meeting. During review of the Simulation Roadmap, Cmdr Richard Weathers agreed to accept **Action Item 9-2** to research the basis of the origin of the TSDF 300% at – 84.5 dBm.
8. The Working Group continued with a review of the “Key Physical Layer Parameters” which need to be decided upon for inclusion in the UAT MOPS. All of the undecided elements were highlighted in yellow, as shown in the initial matrix at the end of these Minutes in Figure 1. The matrix shown in Figure 1 was the final matrix agreed upon at the close of Meeting 8 in Norfolk. Following a review of this matrix in view of simulation results available, the Working Group agreed to remove the yellow shading from the power levels of the B2 equipment class. This was the only change applied to this matrix for the remainder of the meeting. Thus, the modified matrix with agreed to B2 power levels of 28 – 32 dBm will be the beginning point for discussions in Meeting #10.
9. Following Agenda Item 5b, Tom Pagano presented a chart in response to Action Item 7-6, which represents UAT Self Interference relative to the Pre-MOPS Units. This chart was assigned a Working Paper number of UAT-WP-9-12 and will be posted on the ADS-B/UAT web site after the meeting.

10. In conjunction with Agenda Item 5d, Mike Biggs began review of Working Paper WP-9-05. It was noted that WP-9-05 is only a start at defining the Standard Interference Environment and that there were values in the tables of WP-9-05 that would be corrected for the next meeting. Larry Bachman accepted **Action Item 9-9** to scale down aircraft equipment from 2015 levels in the “current” European DME/JTIDS interference environment to assess what level can be supported while meeting requirements. Alternatively Larry should assess what subset of requirements can be met in the presence of existing 978 MHz DMEs.
11. In conjunction with Agenda Item 5e, Chris Moody reviewed Section 2.2.8.2.5 as part of the response to Action Item 8-2. It was agreed that a subset of WG-5 members would again review Section 2.2 during a teleconference to be held on 15 January at 1pm EST. Chris has established a dial-in capacity of 8 lines for a 4 hour duration at phone number 712-257-2476.
12. The Working Group then began the review of Working Paper WP-9-04A, which was a revised Draft 1 of a proposed Appendix C, which was drafted by John Barrows and Ei Mon Phyu. During the review, it was discovered that the PDF version of the file did not convert the formulas properly. Gary will correct the PDF and re-post the file to the ADS-B/UAT web site after the meeting. Gary will also report this as a bug in Acrobat to Adobe.
13. Agenda Item 6 had two Working Papers submitted for the response to Action Item 8-7. The Working Group began the review of planned testing for the Pre-MOPS units by reviewing Working Paper WP-9-06 by Tom Pagano. The Working Group continued discussion of testing Pre-MOPS units with the review of WP-9-09 by Tom Wright and a list of questions, which Tom Wright had received from another reviewer of the Working Paper at JSC.
14. At this point in the meeting, it was mid-afternoon on Tuesday and the WG-5 meeting was about to be interrupted by the RTCA SC-186 Plenary on Wednesday and Thursday, 12-13 December. The Working Group therefore halted review of Working Papers and began a review of the Working Group 6 proposed changes to DO-242 with respect to the Intent and TCP issues. WG-5 reviewed the presentation that WG-6 was to give on Intent and discussed how the proposed changes would affect the UAT MOPS.
15. Following discussion of the proposed changes to DO-242, the Working Group reviewed a presentation on the status of the UAT MOPS effort, which had been prepared by the Co-Chairs prior to and during this meeting.
16. After the review of the WG-5 Status to Plenary, there was sufficient time left in the day to turn attentions to Agenda Item 8c and begin the review of revised pieces of Section 2.2. Chris Moody stepped through each of the pieces of Section 2.2 that he had made changes to since the last draft was reviewed in Norfolk. As the review proceeded to Section 2.2.2.4, the Working Group jumped to Working Paper WP-9-02, and reviewed the presentation from Warren Wilson on the “Eye Diagram.” This review ended the day on Tuesday, 11 December and most Working Group members then attended the RTCA SC-186 Plenary, also at RTCA Headquarters on 12-13 December.
17. A major issue brought before the RTCA SC-186 Plenary was the proposed changes to the ADS-B MASPS, DO-242. Three major changes were discussed in depth by WG-6, but attendees were referred to the list of Issue Papers on the ADS-B/242A web site for review of all of the proposed 23 changes that are targeted to be included in the draft of DO-242A, which is currently scheduled to come before the next RTCA SC-186 Plenary, 10 April 2002. Of the three major issues discussed, the change proposed to Intent and TCP will affect the UAT MOPS the most. At the end of the day on

Thursday, 13 December, the Plenary agreed to the following changes for each equipment class for TCP and Intent.

A0: basic state vector broadcast capability; TSR not allowed.

A1: TSR is allowable option (update rate defined if option is exercised), the data structure for TSR is defined in the MASPS (20 mile range).

A2: TSR is required and Single TCR is required, TCR will be defined in the body of the MASPS, and update rate is defined in the MASPS (40 mile range).

A3: A2 plus multiple TCRs to support 90 mile range (120 NM desired as in DO-242). Requires support of multiple (initially 2) TCRs. The number of TCRs, and management requirements e.g., report rates are TBD; what we know about multiple TCRs will be described in a non-normative Appendix.

18. At 9am on Friday, 14 December, the regular meeting of Working Group 5 was reconvened with a discussion of the above proposed changes and agreements reached during the Plenary. It was agreed by the Working Group that WG-5 should have a teleconference with WG-6 during the next meeting in Atlanta, which corresponds to the same meeting schedule for WG-6 in Seattle. George Ligler accepted **Action Item 9-11** to firm up the details of the teleconference with Tom Foster of WG-6. The Working Group then placed a call to the conference room at Rockwell Collins in Arlington where WG-6 was also meeting and what followed was a 2 hour discussion of the proposed changes to Intent and the holes that needed to be filled by WG-6 prior to the joint teleconference on 28 January 2002. A subgroup of 8 or so, people from WG-5, WG-6, WG-1 and WG-4 agreed to work toward defining TSR/TCR update rates and finalize those calculations during a joint teleconference to be held at 12noon EST on 14 January 2002.
19. The Working Group then resumed review of UAT MOPS sections with Agenda Item 8h and the review of the proposed Appendix H, as submitted by Warren Wilson in Working Paper WP-7-05. The Working Group asked that Stan Jones be assigned **Action Item 9-14** to perform a detailed review of the proposed Appendix H for discussion at a future meeting.
20. Continuing with the review of draft MOPS sections, the Working Group reviewed Agenda Item 8i and the proposed draft of Appendix I, as submitted by Chris Moody in Working Paper WP-7-03. As we reviewed WP-7-03, the Working Group discussed error in the system relating to GPS. We were referred to the “*2001 GPS Standard Positioning Service (SPS) Performance Standard*” which can be obtained in PDF format at the web site: <http://www.navcen.uscg.gov> Chris will make some changes to Appendix I and resubmit it at a future meeting for review.
21. Continuing with Agenda Item 8j, the Working Group reviewed Working Paper WP-9-07, which is the initial draft of Appendix J, as submitted by John Doughty, and presented by Chris Moody.
22. During each meeting, the Working Group reviews the latest drafts of some of the sections of the proposed UAT MOPS that are made available for that meeting. The following table is the result of the assignments of those writing actions, updated with the most current versions of any draft sections that were available for review during this meeting. The asterisk (*) beside a name indicates the lead person or organization.

File Names	Dated	Description	Responsibility
Sec_1a.pdf	3/27/01	Draft 1 of Section 1 – Introduction	Bill Flathers * Jerry Anderson
Sec_2-1c.pdf	9/21/01	Draft 3 of the General Requirements	Tom Mosher
Sec_2-2g.pdf	12/4/01	Draft 7 of the Equipment Performance Requirements	Chris Moody * Bob Saffell Rich Weathers Jim Maynard JHU-APL (?)
		Section 2.3 – Environmental	Small 2.4 group
		Section 2.4 – Equipment Test Procedures	Tom Pagano * Bob Saffell UPS-AT JHU-APL (?)
		Section 3 – Installed Equipment Performance	
Sec_4c.pdf	6/07/01	Draft 3 of the Equipment Performance Characteristics	Greg Kuehl
App_A5.pdf	12/71/01	Draft 4 of the Glossary and Acronyms	Rich Jennings
App_B2.pdf	7/19/01	Draft 2 of the MASPS Cross Reference Matrix	Greg Kuehl * Jim Maynard Nikos Fistas JHU-APL (?)
App_C1.pdf	11/30/01	Draft 1 of the Example ADS-B Message Encoding	Chris Moody John Barrows Ei Mon Phyu
App_D1.pdf	2/14/01	Draft 1 of the UAT Ground Infrastructure	Ed Valovage * Paul Gross
		Appendix E – Aircraft Antenna Characteristics	
		Appendix F – Link Budgets and Scenario Dependent Ranges	Larry Bachman
		Appendix G – Standard Interference Environments	Mike Biggs
App_H1.pdf	9/14/01	Appendix H – Synchronization Processing Information	Warren Wilson
App_I1.pdf	9/17/01	Appendix I – UAT Timing Considerations	Chris Moody
App_J1.pdf	12/6/01	Draft 1 of the Recommended Report Output Format	Chris Moody Tom Mosher John Doughty

23. The following **Action Items** were identified during the course of this and previous meetings. The asterisk (*) beside a name or organization indicates that they are the lead for the resolution of that Action Item. Actions shown here are those **Action Items** that remain OPEN, in total or in part, after the end of the Meeting being report on in these Minutes.

Action Number	Action Description	Assigned to	Status
3-6	Mike and Gondo to determine criteria for acceptable DME performance in the presence of UAT interference	Mike Biggs Gondo Gulean	Assess again at Meeting 10

Action Number	Action Description	Assigned to	Status
4-3	Run his models on all JTIDS scenarios (9), two 1 MHz offset DME scenarios, and self interference, as appropriate to the JTIDS scenarios, with power levels agreed to at Meeting #9 -- with labeled axes (and no yellow lines) – Meeting 10	Stan Jones	
6-6	Draft Appendix B.2 on FIS-B MASPS compliance.	George Ligler Chris Moody	Assess at Meeting 10
8-9	Run the simulations for LA2020 and Core Europe 2015 for switched A1, at power levels of 38.5 to 42.5 dBm for 20NM air-to-air, 150NM air-to-ground, 84% of the A1's below 18,000 ft only.	Larry Bachman Mike Castle	
8-11	Revalidate the co-site testing on the Pre-MOPS boxes, stretching 1090 pulses until it breaks.	Tom Pagano	
8-14	How many transmissions in the ground segment before we lose continuity.	Larry Bachman Stan Jones	
8-16	Draft of Section 2.2.6.3.3 for the December Meeting #9, regarding Latency for NUC ≤ 7 and for > 7 .	George Ligler (*) Stan Jones	Assess at Meeting 10
9-1	Provide definition of TACAN pulses to Larry Bachman for modeling in simulations	Tom Wright	
9-2	Research the basis of the origin of the TSDF 300% at -84.5 dBm	Rich Weathers	
9-3	Look at the 4 dB difference between MER and BER for DME – provide appropriate tests to put correct factor into the MAUS.	Tom Pagano (*) Pre-MOPS Team	
9-4	Get a number to Mike Biggs for the recommended power of the Ground Station	Chris Moody Ed Valovage	
9-5	Reduce the minimum power to 38.5 dBm for low altitude A1 (84% of A1 equipment below 18000 ft), and assess how they perform. Presuming that air-to-air performance is met, indicate what improvements to the Ground System are necessary, if any, to achieve 150 NM air-ground coverage. Will run this simulation(s) with probes.	Larry Bachman Chris Moody Ed Valovage Tom Mosher	
9-6	Need simulation of reception by an aircraft at 2000 ft of ground vehicles that are 7 NM away.	Larry Bachman	
9-7	Run simulation for future Core Europe for victim receiver at worst DME location.	Larry Bachman	
9-8	Run simulation with cavity filter for ground station and sensitivity analysis for 100 w DME as opposed to 10000 w DME.	Larry Bachman	
9-9	Scale down aircraft equipage in the current European environment to assess what level can be supported while meeting requirements. Alternatively assess what subset of requirements can be met in the presence of existing 978 MHz DMEs.	Larry Bachman	
9-10	Investigate ADS-B Message overlaps (more than 2) statistics for Meeting 10 in Atlanta.	Warren Wilson (*) Larry Bachman	
9-11	Coordinate with Tom Foster of WG-6 to plan a joint Teleconference for Monday afternoon, 28 January to resolve some of the open issues with Intent/TCP (1pm EST)	George Ligler	
9-12	Coordinate and participate in the teleconference with WG6 to be held on 14 January at 12:00 EST concerning DO-242A Intent requirements and UAT response. WG6 participants are to include Tony Warren, Richard Barhydt. WG1 will be represented by Bob Hilb. Chris Moody will ask Jonathon Hammer to participate.	Chris Moody (*) Stan Jones Warren Wilson Tom Mosher Jim Maynard	

Action Number	Action Description	Assigned to	Status
9-13	Assess TCR reception performance at 50 NM and 90 NM at 95% in Future Core Europe for A3 equipment transmitting each TCR once per epoch. Try to complete prior to 12 January 2002.	Larry Bachman	
9-14	Give a detailed review of the draft of Appendix H, which is currently available as WP-7-05.	Stan Jones	

24. The **Working Papers** shown in the following table are specifically for the Meeting being reported in these Meeting Minutes. Working Papers for all WG-5 Meetings, as well as the Meeting Agendas, Meeting Minutes, Meeting Schedules and files leading to the production of a UAT MOPS are posted on the ADS-B UAT web site at: <http://adsb.tc.faa.gov/ADS-B/186-subf.htm>

Working Paper	Size	Description	Introduced At:
UAT-WP-9-01	196KB	Draft 7 of Section 2.2 of the UAT MOPS, presented by Chris Moody	Meeting #9, 12/10/01 RTCA
UAT-WP-9-02	24KB	The Use of the Eye Diagram to Specify UAT Transmission Accuracy, presented by Warren Wilson in response to Action Item 7-2	Meeting #9, 12/10/01 RTCA
UAT-WP-9-03B	19KB	Proposed Simulation Roadmap, presented by Chris Moody	Meeting #9, 12/10/01 RTCA
UAT-WP-9-04A	179KB	Draft 1 of a Proposed Appendix C showing example ADS-B Messages, presented by John Barrows and Ei Mon Phyu	Meeting #9, 12/10/01 RTCA
UAT-WP-9-05	19KB	A draft for the Standard Interference Environment assumptions for UAT, presented by Tom Pagano in response to Action Item 8-05	Meeting #9, 12/10/01 RTCA
UAT-WP-9-06	27KB	Outline of the MER Testing including UAT self interference, JTIDS and DME interference, presented by Tom Pagano in response to Action Item 8-07	Meeting #9, 12/10/01 RTCA
UAT-WP-9-07	9KB	Draft 1 of proposed Appendix J "Reference Upper-Layer Protocol for UAT Serial Interface, prepared by John Doughty and presented by Chris Moody	Meeting #9, 12/10/01 RTCA
UAT-WP-9-08	10KB	Guidance on using the UAT datalink ability to measure the range to target by using the Time of Message Receipt (TOMR) value, presented by Tom Mosher	Meeting #9, 12/10/01 RTCA
UAT-WP-9-09	101KB	Test Plan for UAT Datalink Performance Testing of Pre-MOPS UAT Equipment with JTIDS, DME and UAT Pulsed RF Environments, presented by Tom Wright in response to Action Item 8-7	Meeting #9, 12/10/01 RTCA
UAT-WP-9-10	19KB	Asia-Pacific DME Environments, presented by Albert Muaddi in response to Action Item 8-10	Meeting #9, 12/10/01 RTCA
UAT-WP-9-11	132KB	Preliminary UAT Model Results, presented by Larry Bachman in response to Action Items 8-3, 8-4, 8-8 and 8-9	Meeting #9, 12/10/01 RTCA
UAT-WP-9-12	20KB	Chart submitted by Tom Pagano in response to Action Item 7-6 relative to the UAT Self Interference of Pre-MOPS Units	Meeting #9, 12/10/01 RTCA

25. As part of an on-going effort to retain knowledge of items that might otherwise be forgotten, we have created and maintain the following table of "Un-Resolved" or "Orphaned" Issues. This list is reviewed during each meeting and is updated as needed.

Issue #	Issue/Question Description	Raised by	Date Raised	Status
5	Can a minimal installation without an “On Ground” indication continue alternating top and bottom antennas for transmit without significantly sacrificing performance?	Chris Moody UAT-WP-2-06	20 Feb 01	
6	What is the minimum isolation required for antenna switching (20 dB in 1090 MOPS)?	Chris Moody UAT-WP-2-06	20 Feb 01	
10	Whether or not to require an algorithm to determine On-the-Ground status	Section 2.2 discussion	2 May 01	
11	Given that the agreed-upon solution to Coding Selected Altitude appears to add 2 bits, we will remember that we can revisit this issue later if we need to recover those bits.	Discussion on Coding Selected Altitude in WP-4-03	3 May 01	

Figure 1
Key Physical Layer Parameters to be Decided for Inclusion in the UAT MOPS at the end of Meeting 8

ADS-B Equipment Classes Supported in UAT MOPS							
		A0 (will this Class exist??)	A1	A2	A3	B1 (Aircraft Tx-only)	B2 (Ground Vehicle Tx Subsystem)
Message structure and FEC definition		Short ADS-B → RS (30,18); Long ADS-B → RS (48,34); Uplink → 6XRS(92,72) interleaved					
Transmitter ERP (dBm at antenna end of feedline)		38.5-42.5	42-46 (Lower power for low altitude subclass possible)	42-46	50 – 54	Same as A1	28-32
Receiver Sensitivity (dBm for 90% MSR at antenna end of feed line)		-93	-93	-93	-93	N/A	N/A
RX Filtering		Regular selectivity requirement (1.2 MHz)	Regular selectivity requirement (1.2 MHz)	Regular selectivity requirement (1.2 MHz)	Narrow selectivity requirement (0.8 MHz)	N/A	N/A
Antenna Diversity	TX	Bottom only	Alternate T/B*	Alternate T/B	Alternate T/B	Same as A1*	Single Antenna
	RX	Bottom only	Alternate T/B*	Full time dual	Full time dual	N/A	N/A

*Single antenna exemptions for special categories of aircraft (e.g. balloons and gliders)

Yellow highlight shows areas yet to be closed by the MOPS committee